PATENT APPLICATION
Attorney Docket: 10030089-1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF APPEALS

Applicant:	Berberian, et al
Serial No.:	10.805,005
Filed:	3/18/2004
For:	Method and Apparatus for Reducing Errors due to Line Asymmetry in Devices Utilizing Coherent Population Trapping
Group Art Unit:	2817
Examiner:	Goodley, James

BRIEF FOR APPELLANT

Commissioner For Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This is an appeal from the decision of the Primary Examiner dated 2/5/2007, finally rejecting Claims 1-23 in the above-identified patent application.

I. REAL PARTY IN INTEREST

The real party in interest is Agilent Technologies having an address as indicated below.

II. RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to appellant, the appellant's legal representative, or assignee which will directly affect or be directly affected by or have a bearing on the Board's decision in this pending appeal.

III. STATUS OF THE CLAIMS

Claims 1-23 are currently pending in the above-identified patent application. In the Office Action dated 2/5/2006, the Examiner rejected Claims 1-23 and indicated that the Action was final.

IV. STATUS OF AMENDMENTS

An amendment under 37 C.F.R. 1.116 was filed on 4/23/2007. In an advisory action dated 5/18/2007, the Examiner indicated that the amendment would not be entered on filing an appeal. The attached claims therefore do not reflect this amendment.

V. SUMMARY OF THE CLAIMED SUBJECT MATTER

The present invention is directed to an apparatus and method for providing a frequency standard by measuring coherent population trapping (CPT). With respect to the apparatus claimed in Claim 1, refer to Figure 7 and the discussion thereof that begins on page 8 at line 9 of the present application. A source 101 produces electromagnetic radiation with two CPT-generating frequency components, at ν_L-ν and ν_L+ν. These two components irradiate a quantum absorber 102 with two low energy states coupled to a common high energy state, and induce transitions between the two low energy states and the common high energy state. Electromagnetic radiation leaving the quantum absorber falls on photodetector 103 generating a detector signal related to the power of that radiation. The detector signal exhibits an asymmetry as a function of the modulation frequency ν in a frequency range about a frequency ν_0, and feeds into a CPT servo loop, shown in Figure 7 as including an error detector 106, a servo controller 107 and VCO 109. This CPT servo loop alters the optical modulation frequency ν in response to the detector signal. The detector signal also feeds into an asymmetry servo loop, shown in Figure 7 as including an asymmetry error detector 107, and the servo controller 108. This asymmetry servo loop alters either ν_L or one of the two CPT component amplitudes in a manner that reduces the asymmetry.

Claim 2 specifies the addition of an EM frequency control circuit, shown in Figure 7 as including the optical controller 112, that responds to an EM frequency control signal to determine ν_L. Claim 3 adds the requirement that the EM frequency control signal specified in Claim 2 is altered by the asymmetry servo loop specified in Claim 1.

Claim 4 relates to the apparatus described in Claim 1 and further specifies the addition of an AC Stark shift servo loop, shown in Figure 7 as including the AC Stark shift detector 106. This AC Stark shift servo loop generates a Stark shift control signal which determines the amplitudes and/or frequencies of additional frequency components which are generated by the electromagnetic radiation source 101 and alter an AC Stark shift in the quantum absorber 102.

Claims 5-8 relate to the electromagnetic radiation source 101. Claim 5 requires the addition of a modulator, so that the central frequency ν_L of the source is set in response to a first signal, and the modulation frequency imposed on the generated electromagnetic radiation is determined by a second control signal. Claim 6 adds the requirement of a third control signal to the modulator, causing the phase or frequency and the amplitude of the generated radiation to be modulated. In this case the asymmetry servo loop alters either the second or the third control signals. Claim 7 specifies that the radiation source in the source-plus-modulator apparatus of Claim 5 is a laser, while Claim 8 specifies that the source in the apparatus of Claim 1 is made up of two phase-locked lasers.

Claims 9-12 relate to the quantum absorber 102. Claim 9 concerns the dependence of the energy separation of the low energy states of the absorber on an externally applied electromagnetic field, while Claims 10, 11, and 12 relate to the chemical composition of the quantum absorber.

With respect to the method claimed in Claim 13, refer to Figure 7 and the discussion thereof that begins on page 8 at line 9 of the present application. The method comprises irradiating a quantum absorber 102 with two CPT-generating frequency components of EM radiation that induce transitions between the two low energy states and the common high energy state of that quantum absorber, generating a corresponding detector signal exhibiting an asymmetry as a function of modulation frequency ν, altering ν in response to the detector signal; and then altering either the optical frequency ν_L mid way between the frequencies of the two CPT-generating components or the amplitude of one of the two CPT-generating components in a manner that reduces the asymmetry of that detector signal.

Claim 14 additionally specifies that ν_L is altered in response to an EM control signal determined by the detector signal. Claim 15 concerns the generation of additional frequency components to reduce an AC Stark shift in the quantum absorber.

Claims 16-19 relate to the electromagnetic radiation source. Claim 16 simply specifies that the electromagnetic radiation required to carry out the method of Claim 13 is generated by modulating electromagnetic radiation from an electromagnetic radiation source. Claim 17 specifies the optical frequency and the modulation frequency of a source that generates the radiation required by the method of Claim 16. Claim 18 specifies that the radiation source used in the method of Claim 17 is a laser, while Claim 19 specifies that the source in the method of Claim 13 is made up of two phase-locked lasers.

Claim 20 concerns the dependence of the energy separation of the low energy states of the absorber on an externally applied electromagnetic field, while Claims 21, 22, and 23 relate to the chemical composition of the quantum absorber.

VI. GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

A. Rejection of Claims 1-11 and 13-22 under 35 U.S.C. 102(b) as being anticipated by Zhu (US 6,363,091)

B. Rejection of Claims 12 and 23 under 35 U.S.C. 103(a) as being unpatentable over Zhu (of record)

VII. ARGUMENT

A. Examiner's Burden under 35 U.S.C. 102

The Examiner has the burden of showing by reference to the cited art each claim limitation in the reference. Anticipation under 35 U.S.C. 102 requires that each element of the claim in issue be found either expressly or inherently in a single prior art reference. In re King, 231 USPQ 136, 138 (Fed. Cir. 1986); Kalman v. Kimberly-Clark Corp., 218 USPQ 781, 789 (Fed. Cir. 1983). The mere fact that a certain thing may result from a given set of circumstances is not sufficient to sustain a rejection for anticipation. *Ex parte Skinner*, 2

USPQ2d 1788, 1789 (BdPatApp&Int 1986). "When the PTO asserts that there is an explicit or implicit teaching or suggestion in the prior art, it must indicate where such a teaching or suggestion appears in the reference" (*In re* Rijckaert, 28 USPQ2d, 1955, 1957).

Under the doctrine of inherency, if an element is not expressly disclosed in a prior art reference, the reference will still be deemed to anticipate a subsequent claim if the missing element "is necessarily present in the thing described in the reference" Cont'l Can Co. v. Monsanto Co., 948 F.2d 1264, 1268, 20 USPQ2d 1746, 1749(Fed. Cir. 1991). "Inherent anticipation requires that the missing descriptive material is 'necessarily present,' not merely probably or possibly present, in the prior art." Trintec Indus., Inc. v. Top-U.S.A. Corp., 295 F.3d 1292, 1295, 63 USPQ2d 1597, 1599(Fed. Cir. 2002) (quoting In re Robertson, 169 F.3d 743, 745, 49 USPQ2d 1949, 1950-51 (Fed. Cir. 1999)).

B. Examiner's Burden under 35 U.S.C. 103

To sustain a rejection under 35 U.S.C. 103, the Examiner must show that the combined references teach each of the elements of the claim or that there is some motivation in the art for altering one of the teachings to arrive at the combined set of teachings. "The mere fact that a reference could be modified to produce the patented invention would not make the modification obvious unless it is suggested by the prior art." (*Libbey-Owens-Ford v. BOC Group*, 4 USPQ 2d 1097, 1103). In addition, the Examiner must show that there is some motivation in the art that would cause someone of ordinary skill to combine the references, and that in making the combination, there was a reasonable expectation of success. Where the claimed subject matter has been rejected as obvious in view of a combination of prior art references, a proper analysis under section 103 requires, *inter alia*, consideration of two factors: (1) whether the prior art would have suggested to those of ordinary skill in the art that they should make the claimed composition or device, or carry out the claimed process; and (2) whether the prior art would also have revealed that in so making or carrying out, those of ordinary skill would have a reasonable expectation of success. Both the suggestion and the reasonable expectation of success must be founded in the prior art, not in the applicant's disclosure. *In re Vaeck*, 20 USPQ2d 1438, 1442(CAFC 1991).

C. Rejection of Claims 1, 13, and the claims dependent therefrom as being anticipated by Zhu

Claim 1 requires a detector that generates a signal related to the power of the electromagnetic radiation that leaves a quantum absorber that is irradiated by an electromagnetic radiation source having first and second CPT components with frequencies $v_L \pm v$. The detector signal must exhibit an asymmetry as a function of frequency v in a frequency range about a frequency v_0. In addition, the apparatus must include an asymmetry servo loop that alters one of v_L, the first CPT component amplitude, and the second CPT component amplitude in a manner that reduces the asymmetry in the detector signal.

The Examiner maintains that Zhu teaches all the limitations of claim 1. The Examiner points to Figure 5D and lines 11-28 of Column 12 of Zhu as providing these teachings. In particular, the Examiner points to the AC Stark shift servo loop taught in lines 8-19 of Column 15 and Figure 7 of Zhu, including detector 261, control signal 265 and spectrum control 214, as providing the asymmetry servo loop. The Examiner stated that as the carrier is "modulated according to the various servo feedback loops, an asymmetry in the carrier frequency will necessarily result in an asymmetry of the modulated frequency at the detector". The asymmetry to which the Examiner points is the difference in amplitude of the two CPT generating components that can occur under some circumstances.

First, Applicant submits that the assumption that an asymmetry in the carrier frequency, i.e., a difference in amplitudes of the CPT components, will necessarily result in an asymmetry in the detector signal as a function of modulation frequency is flawed. The function measured by the detector is the transmission of the absorber as a function of the modulation frequency, i.e., the difference in frequencies of the two CPT generating components. The Examiner's argument rests on the assumption that a difference in the amplitudes of the two components gives rise to a difference in the absorption of the light passing through the absorber when the separation of the two components changes without changing the height of either CPT generating component. The Examiner has not pointed to any teaching in the art to support this contention.

Second, the Examiner has not pointed to any teaching that the AC Stark servo loop identified by the Examiner inherently reduces an asymmetry in the detector signal as a function of the modulation frequency. The AC Stark effect is a dependence of the separation

of the two low-energy states involved in the CPT effect on the intensity of the light that illuminates the quantum absorber. Since, the laser intensity is not controllable to the degree necessary for a high precision frequency source, the input spectrum of the light is adjusted in a manner that reduces the dependence of the frequency difference between the two low-energy states on laser intensity. This is normally accomplished by add frequency components in addition to the CPT generating components to the input light by controlling the modulation depth of the laser signal to create additional harmonics beyond the CPT components. The present invention is based on the observation that such AC Stark servo loops do not reduce the asymmetry in question here, and hence, an additional servo loop is needed. Furthermore, Zhu teaches that the modulation frequency is modified to provide components in addition to the CPT generating components and that these additional components are optimized to reduce the AC Stark effect. Accordingly, Applicant submits that the Examiner has not shown that the detector signal identified by the Examiner has the recited asymmetry, and that the AC Stark servo loop identified by the Examiner, or any other servo loop in Zhu, acts to reduce such an asymmetry. Hence, Applicant submits that Claim 1 and the Claims dependent therefrom are not anticipated by Zhu.

Claim 13 also requires a detector that generates a signal related to the power of the electromagnetic radiation that leaves a quantum absorber that is irradiated by an electromagnetic radiation source having first and second CPT components having frequencies $\nu_L \pm \nu$. The detector signal must exhibit an asymmetry as a function of frequency ν in a frequency range about a frequency ν_0. In addition, the one of ν_L, said first CPT component amplitude, and said second CPT component amplitude are altered in a manner that reduces said asymmetry. However, this claim does not require a servo loop per se. As noted above, there is no teaching that the servo loop identified by the Examiner alters the recited elements to reduce an asymmetry as a function of frequency as required by this claim. In addition, as noted above, there is no teaching that the detector signal exhibits the required asymmetry. Hence, Applicant submits that Claims 13, and the claims dependent therefrom are not anticipated by Zhu.

D. Rejection of Claims 3 and 14 as being anticipated by Zhu

Claim 3, which depends from Claim 1 through Claim 2 additionally requires that the laser frequency, v_L, is altered by the asymmetry servo loop in response to the asymmetry of the detector signal. The Examiner has not pointed to any teachings in Zhu that the laser frequency is altered in response to an asymmetry in the detection signal of any kind. Hence, Applicant submits that there are additional grounds for allowing Claim 3.

Claim 14 requires that the alterations in the laser frequency that are used to reduce the asymmetry are performed by altering a control signal that sets the laser frequency. As noted above, the AC Stark servo loop identified by the Examiner does not alter the laser frequency. Hence, there are additional grounds for allowing Claim 14.

E. Rejection of Claims 12 and 23 under 35 U.S.C. 103(a) as being unpatentable over Zhu.

Claims 12 and 23 depend from Claims 1 and 13 and require that the quantum absorber include an ion selected from the group consisting of Be^+, Mg^-, Ca^+, Sr^+, Ba^+, Zn^-, Cd^+, Hg^+, and Yb^-. The Examiner admits that Zhu does not teach a quantum absorber meeting this limitation. The Examiner maintains that it would be obvious to modify the teachings of Zhu to include a quantum absorber having an ion of an isotope because such a choice would ensure the desired frequency and energy level transitions for the frequency standard. The Examiner does not provide any insight into what the desired frequency and energy level transitions should be or why they are not obtainable using the isotopes taught in Zhu.

The Examiner states that Zhu suggests that Cesium, Rubidium, any other alkali metal, or any other suitable atoms, ions or molecules may be used in the quantum absorber. The Examiner maintains that since the alkali metals are in group IA of the Periodic Table, and the ions specified in the Claims in question are from group IIA and IIB of the Periodic Table, "these elements must have similar properties" including similar ionization energies. The Examiner then suggests that "these similar ionization energies would translate to similar operational frequencies in a CPT system" and hence, "one might choose among these elements based on the desired frequency of operation in a CPT frequency standard".

First, Applicant repeats the arguments made above with respect to the missing teachings in Zhu with respect to Claims 1 and 13. The Examiner has not pointed to any teaching in the art that would cause someone of ordinary skill to modify the teachings of Zhu to arrive at the limitations of Claims 1 and 13.

Second, Applicant disagrees with the Examiner's argument as to why the elements in question would have similar properties to those taught in Zhu. Applicant submits that the properties of elements vary significantly within and between different groups in the Periodic Table, even for those groups that are relatively closely situated. Ionization energy, in particular, is known to decrease as one moves from top to bottom within a group, and to increase as one moves from left to right from group to group across the Periodic Table. See, for example, http://ocikbws.uzh.ch/education/Elemnet/structure/periodic/trends/step2.html

In addition, the Examiner has not pointed to any teaching in the art that ionization energies in any way correlate to transitions that are suitable for use in a CPT trapping system. The transitions in question require two closely spaced ground states that can be reached by a transition to a common high-energy state of the ions in question. These energy states are not predictable from the ionization energies, i.e., the energy required to strip an outer shell electron from an atom of the element.

Accordingly, Applicant submits that the Examiner has failed to make a *prima facie* case for obviousness with respect to Claims 12 and 23.

VIII. CONCLUSION

Applicant respectfully submits that for the reasons of fact and law argued herein, the decision of the Examiner in finally rejecting Claims 1-23 should be reversed.

I hereby certify that this paper (along with any others attached hereto) is being sent via facsimile to fax number: 571-273-8300

Respectfully Submitted,

Calvin B. Ward
Registration No. 30,896
Date: June 4, 2007

Agilent Technologies, Inc.
Legal Department, M/S DL429
Intellectual Property Administration
P.O. Box 7599
Loveland, CO 80537-0599
Telephone (925) 855-0413
Telefax (925)855-9214

APPENDIX

THE CLAIMS ON APPEAL:

1. An apparatus comprising:

a quantum absorber comprising a material having first and second low energy states coupled to a common high energy state, transitions between said first low energy state and said common high energy state or between said second low energy state being induced by electromagnetic radiation;

an electromagnetic radiation source that generates electromagnetic radiation having first and second CPT-generating frequency components, said first CPT-generating frequency component having a frequency ν_L-ν, and a first CPT component amplitude and said second CPT -generating frequency component having a frequency ν_L+ν and a second CPT component amplitude, said first and second CPT-generating frequency components irradiating said quantum absorber;

a detector for generating a detector signal related to the power of electromagnetic radiation that leaves said quantum absorber, said detector signal exhibiting an asymmetry as a function of frequency ν in a frequency range about a frequency ν_0;

a CPT servo loop that alters ν in response to said detector signal; and

an asymmetry servo loop that alters one of ν_L, said first CPT component amplitude, and said second CPT component amplitude in a manner that reduces said asymmetry.

2. The apparatus of Claim 1 further comprising an EM frequency control circuit that determines ν_L, said EM control circuit being responsive to an EM frequency control signal.

3. The apparatus of Claim 2 wherein said asymmetry servo loop alters said EM frequency control signal.

4. The apparatus of Claim 1 wherein said electromagnetic radiation source further generates additional frequency components for altering an AC Stark shift in said quantum absorber, said additional frequency components having amplitudes and/or frequencies that are determined by a Stark shift control signal,

and wherein said apparatus further comprises an AC Stark shift servo loop for generating said Stark shift control signal.

5. The apparatus of Claim 1 wherein said electromagnetic radiation source comprises:

a source that generates electromagnetic radiation having a frequency ν_L in response to a first signal; and

a modulator that modulates said generated electromagnetic radiation at a frequency determined by a second control signal.

6. The apparatus of Claim 5 wherein said modulator also modulates the phase or frequency and amplitude of said generated radiation in a manner determined by a third control signal and wherein said asymmetry servo loop alters one of said second and third control signals.

7. The apparatus of Claim 5 wherein said source comprises a laser.

8. The apparatus of Claim 1 wherein said electromagnetic radiation source comprises first and second phase-locked lasers.

9. The apparatus of Claim 1 wherein said first and second energy states of said quantum absorber differ in energy by an amount that is a function of an externally applied electromagnetic field.

10. The apparatus of Claim 1 wherein said quantum absorber comprises hydrogen, or an alkali metal or an ion from group IIA and IIB, or Yb^+.

11. The apparatus of Claim 10 wherein said alkali metal is an isotope selected from the group consisting of lithium, sodium, potassium, rubidium, and cesium.

12. The apparatus of Claim 10 wherein said ion is an isotope selected from the group consisting of Be^+, Mg^-, Ca^-, Sr^+, Ba^+, Zn^+, Cd^+, Hg^+, and Yb^-.

13. A method for measuring CPT comprising:

irradiating a quantum absorber comprising a material having first and second low energy states coupled to a common high energy state, transitions between said first low energy state and said common high energy state or between said second low energy state being induced by electromagnetic radiation with electromagnetic radiation having first and second CPT-generating frequency components, said first CPT-generating frequency component having a frequency ν_L-ν, and a first CPT component amplitude and said second CPT generating frequency component having a frequency ν_L+ν and a second CPT component amplitude, said first and second CPT-generating frequency components irradiating said quantum absorber;

generating a detector signal related to the power of electromagnetic radiation that leaves said quantum absorber, said detector signal exhibiting an asymmetry as a function of frequency ν in a frequency range about a frequency ν_0;

altering ν in response to said detector signal; and

altering one of ν_L, said first CPT component amplitude, and said second CPT component amplitude in a manner that reduces said asymmetry.

14. The method of Claim 13 wherein ν_L is altered by altering an EM control signal that controls ν_L in response to said detector signal.

15. The method of Claim 13 further comprising generating additional frequency components to reduce an AC Stark shift in said quantum absorber.

16. The method of Claim 13 wherein said electromagnetic radiation is generated by modulating electromagnetic radiation from an electromagnetic radiation source.

17. The method of Claim 16 wherein said electromagnetic radiation source has a frequency ν_L, and is modulated at a frequency ν.

18. The method of Claim 16 wherein said electromagnetic radiation source comprises a laser.

19. The method of Claim 13 wherein said electromagnetic radiation is generated by first and second phase-locked laser.

20. The method of Claim 13 wherein said first and second energy states of said quantum absorber differ in energy by an amount that is a function of an externally applied electromagnetic field.

21. The method of Claim 13 wherein said quantum absorber comprises hydrogen, an alkali metal or an ion from group IIA and IIB or Yb^+.

22. The method of Claim 21 wherein said alkali metal is an isotope selected from the group consisting of lithium, sodium, potassium, rubidium, and cesium.

23. The method of Claim 21 wherein said ion is an isotope selected from the group consisting of Be^+, Mg^-, Ca^-, Sr^+, Ba^+, Zn^+, Cd^+, Hg^+, and Yb^-.

Evidence Appendix

none

Related Proceedings Appendix

none